CHAPTER 13

Assessment

Reviewing Content

13.1 The Nature of Gases

26. What is meant by an elastic collision?

27. Which of these statements are characteristic of matter in the gaseous state?
   a. Gases fill their containers completely.
   b. Gases exert pressure.
   c. Gases have mass.
   d. The pressure of a gas is independent of its temperature.
   e. Gases are compressible.
   f. The distances between particles in a gas are relatively large.

28. List the various units used to measure pressure, and identify the SI unit.

29. Change 1656 kPa to atm.

30. Convert 190 mm Hg to the following.
   a. kilopascals
   b. atmospheres of pressure

31. Explain the relationship between the Kelvin temperature of a substance and the kinetic energy of its particles.

32. How is the average kinetic energy of water molecules affected when you pour hot water from a kettle into cups at the same temperature as the water?

33. What does the abbreviation STP represent?

34. What is significant about the temperature absolute zero?

35. By what factor does the average kinetic energy of the molecules of gas in an aerosol container increase when the temperature is raised from 27°C (300 K) to 627°C (900 K)?

13.2 The Nature of Liquids

36. Explain why liquids and gases differ in density and the ability to be compressed.

37. Compare the evaporation of a liquid in a closed container with that of liquid in an open container.

38. Describe what is happening at the molecular level when a dynamic equilibrium occurs.

39. Explain why increasing the temperature of a liquid increases its rate of evaporation.

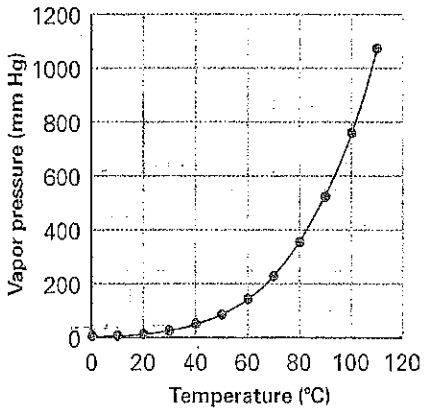
40. Would you expect a dynamic equilibrium in a liquid in an open container? Explain your answer.

41. Describe the effect that increasing temperature has on the vapor pressure of a liquid.

42. Distinguish between the boiling point and the normal boiling point of a liquid.

43. Use the graph to answer each question.

Vapor Pressure vs. Temperature for Water



   a. What is the vapor pressure of water at 40°C?
   b. At what temperature is the vapor pressure of water 600 mm Hg?
   c. What is the significance of the vapor pressure of water at 100°C?

44. Explain how boiling is a cooling process.

13.3 The Nature of Solids

45. Name at least one physical property that would permit you to distinguish a molecular solid from an ionic solid.

46. Describe what happens when a solid is heated to its melting point.

47. Explain why molecular solids usually have lower melting points than ionic solids.

13.4 Changes of State

48. When you remove the lid from a food container that has been left in a freezer for several months, you discover a large collection of ice crystals on the underside of the lid. Explain what has happened.

49. Explain why a liquid stays at a constant temperature while it is boiling.

Understanding Concepts

50. What happens to the average kinetic energy of the water molecules in your body when you have a fever?

51. Refer to Figure 13.9 to answer these questions about chloroform, ethanoic acid, water, and ethanol.
   a. What is the normal boiling point of ethanoic acid?
   b. Which liquid has the highest vapor pressure at 40°C?
   c. At standard atmospheric pressure, which of the substances are in the gaseous state at 70°C?
   d. Water boils at 100°C at standard pressure. How would the pressure on ethanol and on ethanoic acid have to change for these liquids to boil at 100°C?

52. Describe evaporation, vapor pressure, and boiling point.

53. Why is the equilibrium that exists between a liquid and its vapor in a closed container called a dynamic equilibrium?

54. The table gives the vapor pressure of isopropyl alcohol at various temperatures. Graph the data. Use a smooth curve to connect the data points.

Temperature (°C)	Vapor pressure (kPa)
0	1.11
25	6.02
50	23.9
75	75.3
100	198
125	452

   a. What is the estimated normal boiling point of isopropyl alcohol?
   b. What is the boiling point of isopropyl alcohol when the external pressure is increased to twice standard pressure?

55. In a series of liquids, as the intermolecular forces of attraction strengthen, would you expect the vapor pressure to increase or decrease? Explain.

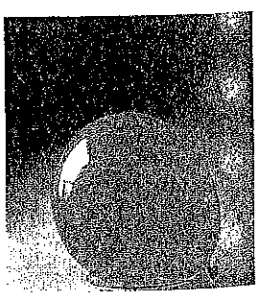
56. Predict the physical state of each of these substances at the indicated temperature. Use the melting point and boiling point data from the table below.
   a. phenol at 99°C
   b. ammonia at −25°C
   c. methanol in an ice-water bath
   d. methanol in a boiling-water bath
   e. ammonia at −100°C
   f. phenol at 25°C

Substance	Melting Point (°C)	Boiling Point (°C)
ammonia	−77.7	−33.4
methanol	−97.7	64.7
water	0	100
phenol	40.9	181.9

57. Mount McKinley in Alaska is the tallest peak in North America at 6194 m. The atmospheric pressure at its peak is 44 kPa. Use Figure 13.9 to find the boiling point of water at the peak of Mount McKinley.

58. What causes atmospheric pressure, and why is it much lower on the top of a mountain than it is at sea level?

59. Pouring liquid nitrogen onto a balloon decreases the volume of the balloon dramatically, as shown in the photograph on the left. In time, the balloon reinflates as shown in the photograph on the right. Use kinetic theory to explain this sequence of events. The temperature of liquid nitrogen is −196°C.



Critical Thinking

60. What role does atmospheric pressure play when someone is drinking a liquid through a straw?

61. Your lab partner measures the boiling point of water in an open beaker as 108.2°C. Even though you know that water can be made to boil at this temperature, you ask your partner to repeat the measurement. Explain.

62. What everyday evidence suggests that all matter is in constant motion?

63. Is the average kinetic energy of the particles in a block of ice at 0°C the same as or different from the average kinetic energy of the particles in a gas-filled weather balloon at 0°C? Explain.

64. Are perfectly elastic collisions possible between objects that are large enough for you to see?

65. How does perspiration help cool your body on a hot day?

66. Why do different liquids have different normal boiling points?

67. There is a liquid–vapor equilibrium in a container. Explain why the vapor pressure in the container is not affected when the volume of the container is changed.

68. A teacher wants to demonstrate that unheated water can boil at room temperature in a beaker within a bell jar connected to a vacuum pump. However, the vacuum pump is faulty and can reduce pressures only to 15 kPa. Can the teacher use this pump to perform the demonstration successfully? Explain your answer.

69. You have two similar sealed jars of water at the same temperature. In the first jar, there is a large amount of water. In the second jar, there is a small amount of water. Explain how the vapor pressure can be the same in both jars even though many more water molecules are evaporating in the first jar.

70. Why are pressure cookers recommended for cooking at high-altitude?

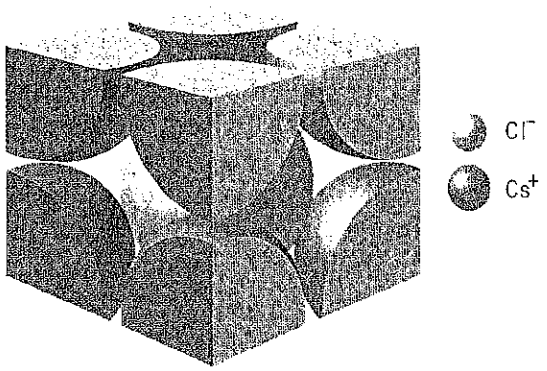
71. A mixture of gases contains oxygen, nitrogen, and water vapor. What physical process could you use to remove the water vapor from the sample?

Concept Challenge

72. The ions in sodium chloride are arranged in a face-centered cubic pattern. Sketch a layer of the ions in a crystal of sodium chloride.

73. Using Figure 13.11, identify the crystal system described by these characteristics.
    a. three unequal edges meet at right angles
    b. three equal edges with three equal angles that are not right angles
    c. two equal edges and one unequal edge meet at right angles
    d. three unequal edges do not meet at right angles
    e. three equal edges meet at right angles

74. Use this drawing to answer the questions.



    a. What type of unit cell is in a lattice of cesium chloride?
    b. What is the coordination number of Cs^+?
    c. Based on the diagram, what is the formula of cesium chloride? Explain your answer.

75. Relative humidity is defined by the following equation

$$\textit{Relative humidity} = \frac{\text{(a)}}{\text{(b)}} \times 100\%$$

where (a) is the pressure of water vapor in the air and (b) is the equilibrium vapor pressure of water in air at the same temperature. Can the relative humidity ever exceed 100%? Explain.

76. The solid-liquid equilibrium line in the phase diagram of a given substance slants to the right. How is the substance's freezing point affected by increased pressure?

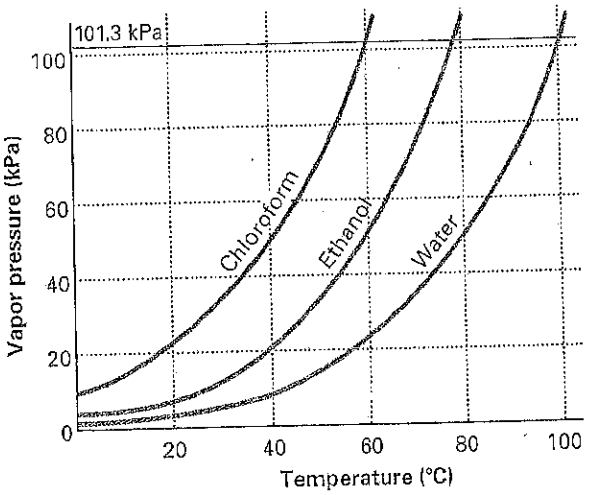
Standardized Test Prep

Test-Taking Tip

Interpreting Graphs A line graph helps you see the relationship between two variables. Before you answer a question about a graph, identify the variables and the general relationship between the variables based on the shape of the curve.

Use the graph to answer Questions 1 and 2.

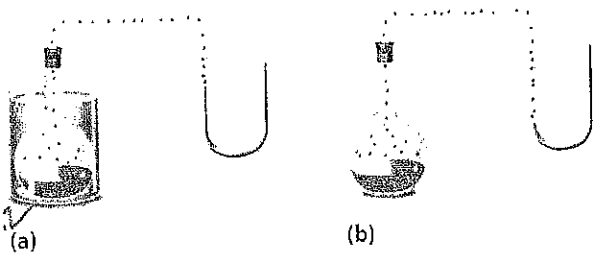
Vapor Pressure Graph of Three Substances



1. What is the normal boiling point of ethanol?
2. Can chloroform be heated to 90°C in an open container?

3. Which sequence has the states of CH_3OH correctly ordered in terms of increasing average kinetic energy?
   a. $CH_3OH(s)$, $CH_3OH(g)$, $CH_3OH(l)$
   b. $CH_3OH(g)$, $CH_3OH(l)$, $CH_3OH(s)$
   c. $CH_3OH(l)$, $CH_3OH(g)$, $CH_3OH(s)$
   d. $CH_3OH(s)$, $CH_3OH(l)$, $CH_3OH(g)$

Use the drawing to answer Questions 4–6. The same liquid is in each flask.



4. In which flask is the vapor pressure lower? Give a reason for your answer.
5. In which flask is the liquid at the higher temperature? Explain your answer.
6. How can the vapor pressure in each flask be determined?

For each question there are two statements. Decide whether each statement is true or false. Then decide whether Statement II is a correct explanation for Statement I.

Statement I		Statement II
7. In an open container, the rate of evaporation of a liquid always equals the rate of condensation.	BECAUSE	A dynamic equilibrium exists between the liquid and its vapor in an open container.
8. Water boils at a temperature below 100°C on top of a mountain.	BECAUSE	Atmospheric pressure decreases with an increase in altitude.
9. The temperature of a substance always increases as heat is added to the substance.	BECAUSE	The average kinetic energy of the particles in a substance increase with an increase in temperature.
10. Solids have a fixed volume.	BECAUSE	Particles in a solid cannot move.
11. Gases are more compressible than liquids.	BECAUSE	There is more space between particles in a gas than between particles in a liquid.